Third United Nations International Conference on the Peaceful Uses of Atomic Energy

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Abstract

A NEW DISTILLATION TECHNIQUE FOR ISOTOPE CONCENTRATION

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It is well known that a liquid can be forced to rise on a vertical surface in the form of liquid thin film, if a gas with a sufficiently high velocity is used as raising agent.

Under these conditions mass transfer takes place in isothermal flow. In the CISE laboratories the application of concurrent two-phase annular flow as a contacting mechanism for the separation of the components of an isotopic mixture was studied since 1957. As a first application, the separation of oxygen-18 and deuterium by water distillation at room temperature, in the presence of an inert gas, was studied.

A 100-stage distillation plant was designed and assembled in order to test the feasibility and the best conditions in which a good contact between the two phases occurs. Air was chosen as the gas carrier. Mass transfer and hydrodynamic behaviour of the plant was studied in 2,000 hours of operation.

A further development of the contact technique was the application of this principle to conventional distillation column in a steam-water system; a suitable type of plate was designed for this purpose. Mass transfer and the hydrodynamic behaviour of a plate were studied in experiments carried out at temperatures ranging from 90° to 110° in a steam-water system.

In many respects this type of plate proved to be more advantageous as compared to conventional distillation plates, so that the investigation was pursued on a laboratory-scale column assembled with 24 plates. The efficiency, pressure drops and equilibrium time of the column were investigated. The column was designed for heavy water separation by fractional distillation, at temperatures ranging from 90° to 101°C. It is shown that concurrent

plates columns make possible a strong reduction in size, as compared to conventional bubble-plate columns; they appear to be easy to control and show a short equilibrium time and a low material hold-up.

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Abstract

SOME RESEARCHES ON THE ENVIRONMENTAL RADIOACTIVE CONTAMINATIONS IN ITALY

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The paper summarizes the work carried out by "Laboratorio per lo Studio della Radioattività Ambientale" under the CNEN-sponsored programme for environmental radioactivity survey. Some of the work concerning sea-water radioactive contamination was carried out by the Engineering Faculty of the Pisa University.

The activity and composition of fall-out collected at the Casaccia Centre for Nuclear Studies were determined during the period from 1961 through 1963. The following radionuclides were measured: Sr^{89}, Sr^{90}, Ce^{141}, $Ce^{144} + Pr^{144}$, Ru^{103}, $Ru^{106} + Rh^{106}$, Sb^{125}, Cs^{137}, $Zr^{95} + Nb^{95}$, Mn^{54}, $Ba^{140} + La^{140}$. The correlation between meteorological features and fall-out deposition was also studied and some detonations were dated.

The methods for chemical separations were chosen, taking into account both reliability and cost. For this reason some methods, previously adopted by other researchers, were considered and sometimes modified. Ion exchangers, both organic and inorganic, were preferred, whenever possible, because of their simple use and low cost. The procedures adopted here were proposed as a basis for a country-wide standardization of measurements of environmental radioactivity.

Some measurements of sea-water activity due to Sr^{89}, Sr^{90} and Cs^{137} were performed during the 1960-1963 period. The sampling points were selected along the Italian coasts and samples were collected at least once or twice a year. Seasonal influences on Sr^{90} contamination were investigated. Besides sea-water, some samples of fishes as well as of other sea-

organisms were collected and the contaminations of Sr^{89}, Sr^{90}, Zr^{95} + Ru^{106} + Rh^{106} were determined therein.

Apart from sea-organisms, the following items of the food chain were taken into consideration: soil, fresh water, hay, wheat, rice, vegetables, meat and milk. A search for Sr^{89}, Sr^{90}, Cs^{137} and I^{131} was conducted in the aforesaid materials. A correlation among the average values of radioactive contaminations in the different phases of the food chain was sought, in an attempt to report some observed ratios.

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Abstract

NUCLEAR POWER IN THE UNITED KINGDOM

by

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The paper describes progress with the U.K. nuclear power programme and provisional plans for its extension into the 1970s.

2. At the time of the second Geneva Conference in 1958, the application of nuclear power was in a comparatively early stage in most countries. The U.K. now has several nuclear power stations operating and by the end of this decade will have about 5000 MWE of nuclear power.

3. Reactor development in the U.K. has been carried from the successful operation of Calder Hall in 1957, through the programme of magnox stations to the operation of the Advanced Gas-Cooled Reactor prototype at Windscale. It includes the co-operative development of the High Temperature Gas-Cooled reactor system in the O.E.C.D. DRAGON Project. The U.K. programme is based on general research on a wide front and development has been broadened to include a major water moderated project (Steam Generating Heavy Water reactor). Good progress has been made with the fast reactor which is being developed with the aim of achieving economic power and high utilisation of natural uranium. Research is also in hand on plutonium enrichment in thermal reactors.

4. The paper discusses questions which have to be answered in making economic assessments. Given the characteristics of nuclear power of low running costs coupled with relatively high capital costs, the assessments are dependent on the economic circumstances and characteristics of the generating system in the country concerned and on the degree of caution applied. These together determine the rates of capital charges and the ground rules assumed. The economic prospects forecast for nuclear power or for individual systems will accordingly vary from country to country.

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* Leader of the United Kingdom Delegation

5. The paper discusses the situation in the U.K. where nuclear power should be economically competitive with conventional power in the 1970's.

6. The Third Geneva Conference has been well timed to show that the long term benefits of introducing nuclear fuels will be realised increasingly as the world demand for electricity increases and as present development programmes bear fruit.

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Abstract

REVIEW OF PROGRESS OF DEVELOPMENT, MANUFACTURE, AND PERFORMANCE OF MAGNOX FUEL ELEMENTS IN THE UNITED KINGDOM

by

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ABSTRACT

INTRODUCTION

1. The progress of the provision of Magnox fuel elements for the United Kingdom Nuclear Power Programme is reviewed in respect of development, manufacture and performance for the interval since the last Geneva Conference. Attention is concentrated on items which can be regarded as of key importance and these are necessarily treated briefly:

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PRESENT POSITION

2. Various aspects of the accelerating build-up of Nuclear Power production in the United Kingdom towards the target of 5,000 MW(E) by 1969 are referred to: the build-up of fuel element production at the Springfields Works of the U.K.A.E.A. in line with requirements (the Sizewell initial fuel charge is currently being manufactured); the very satisfactory behaviour of the Bradwell and Berkeley stations of the Central Electricity Generating Board; and the successful commissioning of Hunterston.

3. Reference is also made to the successful commissioning of the Latina station of the Societa Italiana Meridionale Energia Atomica and to the completion of manufacture of the first charge of fuel for the Tokai Mura station of the Japan Atomic Power Company.

4. Examples of the irradiation levels reached by the various designs of Magnox fuel elements are given.

IMPORTANT DEVELOPMENTS IN THE PERIOD 1959 - 1964

5. Reference is made to the policy adopted of parallel development of alternative solutions for certain key items. Such key items were the canning alloy, the high strength structural alloy for the end fittings of stack-loaded elements, and finally, the uranium fuel rod.

6. The alternatives developed in the instances cited above are referred to and the results obtained both out of pile and from irradiation experiments and large-scale irradiation trials are outlined. Manufacturing processes associated with the alternative solutions are discussed briefly and reference is made where relevant to the impact of the alternative solutions on reactor operations and on the subsequent processing of irradiated fuel.

7. The problems arising from grain boundary cavitation of the canning alloys, the solution adopted, and the manufacturing implications; and the plutonium diffusion problem with the ZR55 canning alloy are referred to. The occasional occurrence of rapid failures during reactor service, the generally accepted explanation of these rapid failures, the development work carried out and in progress, and the impact on manufacturing and reactor operation procedures are also referred to.

8. The highlights of the changes in dimensions in physical properties and in microstructure occurring as a consequence of irradiation of the fuel rods and

canning materials and the results of in-pile thermal cycling experiments on the cans are discussed.

FUTURE TRENDS

9. The view is expressed that the development of Magnox fuel elements has now reached the end of a phase of progressive improvement of the solid cylindrical rod polyzonal heat transfer surface element; further improvements, mainly of a manufacturing nature, will continue, but there is diminishing return for design changes. It is suggested that any fresh advances will have to be achieved with herringbone heat transfer surfaces and tubular or plate-type fuel. A robust but simple herringbone element is visualised. This represents a reversal of the earlier trend, when development work revealed the need for reinforcement and stabilisation of the earliest conceptual designs with the consequential trend to more component parts and greater complication. The robust streamlined designs visualised are expected to ultimately combine the advantages of reduced manufacturing cost with increased endurance in reactor service.

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Abstract

PLANNING FOR NUCLEAR POWER IN THE CENTRAL ELECTRICITY GENERATING BOARD'S SYSTEM

by

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The United Kingdom has undertaken a large nuclear power programme, the construction of the major proportion of which is the responsibility of the C.E.G.B. Two nuclear power stations have been commissioned and are operating successfully. Six others are being built and another is planned. By 1970 it is expected that some 5,000 MW of nuclear capacity will be in service out of a total system output capacity of about 67,000 MW in England and Wales.

Integrating nuclear plant into the system presents economic, technical and social problems. Firm decisions on the capacity and location of new generating and main transmission plant have to be made five years before it is required for service taking into account the rate of demand growth, the pattern of demand, system security and the availability of suitable sites. The economics of individual projects are compared over their useful lives against a postulated background development using the present value concept.

The geographical pattern of electricity demand relative to the central coalfields has a marked effect on the location of coal-fired and nuclear power stations within the country. A new rail transport agreement has made off coalfield generation more attractive but a significant amount of bulk transmission of electrical energy to the South East at high load factor still remains economic. Major oil-fired stations are being sited in close proximity to important oil refineries.

Practical considerations such as finding technically suitable sites for nuclear power stations are equally important. Cooling water presents the major difficulty and for this reason all stations up to 1970, except one, are being sited on the coast or large estuaries. Foundation conditions must be

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able to support the heavy loads imposed by the reactor structures, sufficient land must be available to accommodate the buildings and to permit rapid construction, and good site access is essential. The choice of a site is further restricted by safety considerations. Government policy dictates that these first stations shall be sited in areas of low population density.

So far stations have been located in the load importing areas in the South and North West of the country. It is, however, possible that future stations may be sited elsewhere. Without the existence of a strongly interconnected nation-wide 275 kV transmission system, now in process of conversion to 400 kV, the introduction of nuclear power on its present scale would not have been possible.

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Abstract

RESEARCH IN BRITISH UNIVERSITIES RELATED TO NUCLEAR FUEL REPROCESSING

by

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Some research in British Universities related to the chemistry and technology of nuclear fuel aqueous reprocessing is described.

The breakdown of organic ion exchange resins when exposed to intense ionising radiation has been examined. Strong base resins, containing quaternary ammonium functional groups, lose strong base capacity by loss of tertiary amine, and gain weak base capacity by conversion of the quaternary to an amino group. Measurements are reported of capacity changes and decomposition product yields for several anion exchanger salt systems measured under both static and dynamic bed conditions. In strong nitric acid and under irradiation, the anion exchangers undergo severe damage to the polymer structure. Similar studies on cation exchangers have been made.

Inorganic ion exchange materials are known to be more stable to radiation than organic resins. A quantitative examination of properties of Linde Molecular Sieve 13-X, a synthetic zeolite, shows a remarkably high radiation stability with respect to its structure, sorption and cation exchange capacities. This material

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possesses certain excellent ion exchange properties but is unstable in solutions of pH lower than 5. The exchange equilibria of a variety of cation and anion exchangers based on hydrous zirconia and thoria and on zirconium and thorium phosphates are reported. High specificity can be attained but commercial application is limited due to difficulties in preparing stable reproducible materials and to their limited stabilities in acid solution.

In studies of the chemistry of solvent extraction processes particular attention has been given to acid and neutral phosphate solvents and to the amines tri-n-octylamine and methyl-dioctylamine. Data for the extraction of acids and metal anionic species into these solvents is reported. A number of complexes of NpO_2^+ and NpO_2^{++} have been identified.

The electrolytic dissolution of uranium metal into nitric acid using a tubular dissolver is described. The new dissolver has several advantages over the more familiar basket dissolver. Recent theoretical studies on the dissolution of a cylindrical fuel element in a potential gradient are reported.

The influence of dimensional scale-up and operating variables on the performance of pulsed columns and mixer-settlers using aqueous-dispersed systems are considered. An important aspect of this work has been a fundamental study of coalescence.

Some techniques for continuous countercurrent contact of particulate solids with fluids are described, including a novel technique particularly suitable for processes operating under highly radioactive conditions. Results are reported on the hydrodynamics and mass transfer performance of small-scale equipment operating on ion exchange systems.